CLAIMS

We claim:

1.   A method for 3:2 pull-down film mode detection of a stream of NTSC video fields $\{F[j]\} = \{...F[n-2], F[n-1], F[n], ...\}$, said method comprising the steps of:

a) generating from said $\{F[j]\}$ a sequence $\{S[j]\}$, wherein a $S[n]$ in said sequence denotes an accumulated sum of absolute value of luma difference between two fields $F[n]$ and $F[n-2]$ over a common set of pixel positions;

b) generating from said $\{S[j]\}$ a sequence $\{P[j]\}$ whose elements are in one-to-one correspondence with the elements of said sequence $\{S[j]\}$, wherein a $P[n]$ is assigned a symbol from a two-symbol set by applying a set of fuzzy inference rules; and

c) in response to said $\{P[j]\}$ having a pattern that characterized a stream of 3:2 pull-downed fields, designating said $\{F[j]\}$ as 3:2 pull-downed fields from film source.

2.   The method of claim 1, wherein said two-symbol set is $\{L,H\}$ and wherein said set of fuzzy inference rules are:

with $X[n-1] = |S[n]-S[n-1]|$, $X[n-2] = |S[n]-S[n-2]|$, $X[n-3] = |S[n]-S[n-3]|$, $X[n-4] = |S[n]-S[n-4]|$, and with fuzzy sets of BIG and SMALL defined to characterize sized of $X[n-1]$, $X[n-2]$, $X[n-3]$ and $X[n-4]$,

if $X[n-1]$ is BIG, and $X[n-2]$ is BIG, and $X[n-3]$ is BIG, and $X[n-4]$ is BIG, then $P[n]$ is assigned symbol 'L';

otherwise, $P[n]$ is symbol 'H'.

3.   The method of claim 2, further comprising the steps of:

performing symbol assignment to said $P[n]$ by performing fuzzy logic inference algorithm to implement said set of fuzzy logic inference rules.

4.   The method of claim 3, wherein said fuzzy logic inference algorithm comprises the step of:

defining a fuzzy subset per each fuzzy logic inference rule of said set of fuzzy logic inference rules, thereby resulting in a plurality of fuzzy subsets;

forming a fuzzy union set of said plurality of fuzzy subsets; and

defuzzifying said fuzzy union set by using a center of gravity defuzzification method to generate a value g adapted to determine symbol assignment of said P[n].

5. The method of claim 2, wherein said pattern is selectable from a group consisted of:

LHHHH repeated m times in said {P[j]},

HHHHL repeated m times in said {P[j]},

HHHLH repeated m times in said {P[j]},

HHLHH repeated m times in said {P[j]}, and

HLHHH repeated m times in said {P[j]}, wherein said m is a positive integer.

6. The method of claim 1, wherein in said step c), the signs of Z[n-1] = (S[n]-S[n-1]), Z[n-2] = (S[n]-S[n-2]), Z[n-3] = (S[n]-S[n-3]) and Z[n-4] = (S[n]-S[n-4]) are adapted as a criteria to rule out erroneously designating said {F[j]} as 3:2 pull-downed fields form film source.

7. A method for 3:2 pull-down film mode detection of a stream of NTSC video fields {F[j]} = {...F[n-2], F[n-1], F[n], ...}, said method comprising the steps of:

a) generating from said {F[j]} a sequence {S[j]}, wherein a S[n] in said sequence denotes an accumulated sum of absolute value of luma difference between two fields F[n] and F[n-2] over a common set of pixel positions:

b) for said S[n], characterizing the sizes of X[n-1]= | S[n]-S[n-1] |, X[n-2] = | S[n]-S[n-2] |, X[n-3] = | S[n]-S[n-3] |, X[n-4] = | S[n]-S[n-4] | with their fuzzy memberships in fuzzy logic sets;

c) generating from said {S[j]} a reference sequence {P[j]} whose elements correspond one-to-one to elements of {S[j]}, wherein a P[n] corresponding to said S[n] is assigned a symbol from a set having two symbols by applying fuzzy inference rules, and wherein said P[n] is adapted to summarize the fuzzy set memberships of said X[n-1], X[n-2], X[n-3] and X[n-4] in said fuzzy sets; and

in response to said {P[j]} containing a pattern that characterizes a stream of 3:2 pull-downed fields, designating said {F[j]} as set of 3:2 pull-downed fields from film source.

8.   The method of claim 7, wherein said set of two symbols is {L, H}, wherein said fuzzy sets are defined as BIG and SMALL, and wherein said set of fuzzy inference rules are:

   if X[n-1] is BIG, and X[n-2] is BIG, and X[n-3] is BIG, and X[n-4] is BIG
then

   P[n] is assigned symbol 'L';
   otherwise, P[n] is symbol 'H'.

9.   The method of claim 8, further comprising the steps of:

   performing symbol assignment to said P[n] by performing fuzzy logic inference algorithm to implement said set of fuzzy logic inference rules.

10.   The method of claim 9, wherein said fuzzy logic inference algorithm comprises the step of:

   defining a fuzzy subset per each fuzzy logic inference rule of said set of fuzzy logic inference rules, thereby resulting in a plurality of fuzzy subsets;

   forming a fuzzy union set of said plurality of fuzzy subsets; and

   defuzzifying said fuzzy union set by using a center of gravity defuzzification method to generate a value g adapted to determine symbol assignment of said P[n].

11.   The method of claim 8, wherein said pattern is selectable from a group consisted of:

   LHHHH repeated m times in said {P[j]},

   HHHHL repeated m times in said {P[j]},

   HHHLH repeated m times in said {P[j]},

   HHLHH repeated m times in said {P[j]}, and

   HLHHH repeated m times in said {P[j]}, wherein said m is a positive integer.

12.   The method of claim 7, wherein in said step c), the signs of $Z[n-1] = (S[n]-S[n-1])$, $Z[n-2] = (S[n]-S[n-2]$, $Z[n-3] = (S[n]-S[n-3])$ and $Z[n-4] = (S[n]-S[n-4])$ are adapted as a criteria to rule our erroneously designating said {F[j]} as 3:2 pull-downed fields from film source.

13.   A system for performing 3:2 pull-down film mode detection on a NTSC stream of video fields $\{F[j]\}=\{\ldots F[n-2], F[n-1], F[n],\ldots\}$, said system comprising:

a difference accumulate unit adapted for generating from said $\{F[n]\}$ a sequence $\{S[j]\}$, wherein a $S[n]$ denotes an accumulation sum of absolute value of luma difference between two fields $F[n]$ and $F[n-2]$ over a common set of pixel positions;

a fuzzy logic decision unit adapted for generating from said $\{S[j]\}$ a sequence $\{P[j]\}$ whose elements are in one-to-one correspondence with the elements of said sequence $\{S[j]\}$, wherein a $P[n]$ corresponding to said $S[n]$ is assigned a symbol from a set of two symbols by applying a set of fuzzy inference rules; and

a decision unit adapted for designating said $\{F[j]\}$ by said $\{P[j]\}$ as 3:2 pull-downed fields in response to said $\{P[j]\}$ having a pattern that characterizes a stream of 3:2 pull-downed fields from film source.

14.   The system of claim 13, wherein said set of two symbols is $\{L,H\}$, and wherein said set of fuzzy inference rules are:

with fuzzy sets of BIG and SMALL defined to characterize sizes of $X[n-1]$, $X[n-2]$, $X[n-3]$ and $X[n-4]$ by fuzzy memberships of $X[n-1]$, $X[n-2]$, $X[n-3]$ and $X[n-4]\}$ in said fuzzy sets BIG and SMALL, wherein $X[n-1]=|S[n]-S[n-1]|$, $X[n-2] = |S[n]-S[n-2]|$, $X[n-3] = |S[n]-S[n-3]|$, $X[n-4] = |S[n]-S[n-4]|$,

if $X[n-1]$ is BIG and $X[n-2]$ is BIG, and $X[n-3]$ is BIG, and $X[n-4]$ is BIG, then $P[n]$ is assigned symbol 'L';

otherwise, $P[n]$ is symbol 'H'.

15.   The system of claim 14, wherein said fuzzy logic decision unit is adapted to perform symbol assignment to said $P[n]$ by performing fuzzy logic inference algorithm to implement said set of fuzzy logic inference rules.

16.   The system of claim 13, wherein said fuzzy logic inference algorithm performed by said fuzzy decision unit comprises the step of:

defining a fuzzy subset per each fuzzy logic inference rule of said set of fuzzy logic inference rules, thereby resulting in a plurality of fuzzy subsets;

forming a fuzzy union set of said plurality of fuzzy subsets; and

defuzzifying said fuzzy union set by using a center of gravity defuzzification method to generate a value g adapted to determine symbol assignment of said P[n].

17.   The system of claim 14, wherein said pattern is selectable from a group consisted of:

LHHHH repeated m times in said {P[j]},

HHHHL repeated m times in said {P[j]},

HHHLH repeated m times in said {P[j]},

HHLHH repeated m times in said {P[j]}, and

HLHHH repeated m times in said {P[j]}, wherein said m is a positive integer.

18.   The method of claim 13, wherein said decision unit uses the signs of $Z[n-1] = (S[n]-S[n-1])$, $Z[n-2] = (S[n]-S[n-2])$, $Z[n-3]= (S[n]-S[n-3])$ and $Z[n-4] = (S[n]-S[n-4])$ as a criteria to rule our erroneously designating said {F[j]} as 3:2 pull-downed fields from film source.